

CLAIMS

in Patent Application entitled

CONTROLLED DRIVEN SERIES-RESONANT BALLAST

1. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC supply terminals;

an inverter circuit connected with the DC supply terminals and providing an inverter output voltage at a pair of inverter output terminals; the inverter output voltage (i) consisting of substantially rectangular voltage pulses of alternating polarity, (ii) having a fundamental frequency, and (iii) having a fundamental period; each voltage pulse having a pulse-duration equal to no more than half the duration of the fundamental period; the inverter circuit including a control sub-circuit having a first and a second control input; the control sub-circuit having a clock function operative to determine the fundamental frequency, which fundamental frequency being adjustable in response to receiving a first control signal at the first control input; the control sub-circuit also having a timing function operative to determine the pulse-duration, which pulse-duration being adjustable in response to receiving a second control signal at the second control input;

a tank-inductor and a tank-capacitor series-connected across the inverter output terminals; the tank-inductor and the tank-capacitor having a natural resonance frequency, which natural resonance frequency being about equal to or lower than the fundamental frequency; and

a gas discharge lamp conditionally connected in circuit with the tank-capacitor.

2. The arrangement of claim 1 wherein:

(a) whenever the gas discharge lamp is indeed connected in circuit with the tank-capacitor and is drawing a lamp current, the pulse-duration is equal to about half the duration of the fundamental period; and

(b) whenever the gas discharge lamp is not connected in circuit with the tank-capacitor, the pulse-duration is distinctly lower than half the duration of the fundamental period.

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3. The arrangement of claim 2 wherein, whenever the gas discharge lamp is not connected with the tank-capacitor, the fundamental frequency is distinctly higher than the natural resonance frequency.

4. The arrangement of claim 1 wherein, whenever the gas discharge lamp is indeed connected in circuit with the tank-capacitor and is drawing a lamp current, a substantially sinusoidal load current flows from the inverter output terminals, which substantially sinusoidal load current is out-of-phase with the fundamental voltage component of the inverter output voltage by no more than about plus/minus 30 degrees.

5. The arrangement of claim 1 wherein, whenever the gas discharge lamp is not connected in circuit with the tank-capacitor, a substantially sinusoidal no-load current flows from the inverter output terminals, which substantially sinusoidal no-load current is out-of-phase with the fundamental voltage component of the inverter output voltage by no less than about plus/minus 60 degrees.

6. The arrangement of claim 1 additionally comprising a sensor sub-assembly connected in circuit with the tank-capacitor as well as with the first and second control input; the sensor sub-assembly being operative, in response to an AC voltage present across the tank-capacitor, to provide a first and second sensor output voltage and to apply these to the first and second control input, respectively, thereby to prevent the RMS magnitude of said AC voltage from exceeding a pre-determined level.

7. The arrangement of claim 1 wherein the inverter circuit is further characterized by including a full-bridge inverter connected in circuit between the DC supply terminals and the inverter output terminals.

8. The arrangement of claim 1 wherein the fundamental frequency is affected only by the average magnitude of the first control signal, which average magnitude is obtained by averaging the magnitude of the first control signal over a period at least as long as the duration of the fundamental period.

9. The arrangement of claim 1 wherein the pulse-duration is determined by the magnitude of the second control signal as averaged over a period at least as long as the duration of the fundamental period.

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10. An arrangement comprising:

a load circuit having a pair of load circuit input terminals and a pair of load circuit output terminals; the load circuit output terminals being disconnectably connected with a pair of lamp terminals of a gas discharge lamp; and

an inverter circuit having a pair of DC input terminals connected with a source of DC supply voltage and a pair of AC output terminals connected with the load circuit input terminals; the inverter circuit providing an AC output voltage at the AC output terminals; the AC output voltage (i) consisting of substantially rectangular voltage pulses of alternating polarity, (ii) having a fundamental frequency, and (iii) having a fundamental period; the inverter circuit being further characterized in that: (a) whenever the gas discharge lamp is indeed connected with the load circuit output terminals and is drawing a lamp current therefrom, each voltage pulse has a duration equal to about half the duration of the fundamental period; and (b) whenever the gas discharge lamp is not so connected, each voltage pulse has a duration distinctly shorter than half that of the fundamental period.

11. The arrangement of claim 10 wherein the load circuit additionally includes an inductor and a capacitor connected in circuit with the load circuit input terminals as well as with the load circuit output terminals; the inductor and the capacitor forming a tuned circuit having a natural resonance frequency about equal to or lower than said fundamental frequency.

12. The arrangement of claim 10 wherein the load circuit draws a substantially sinusoidal load current from the AC output terminals and: (a) whenever the gas discharge lamp is indeed connected with the load circuit output terminals and is drawing a lamp current therefrom, the load current is out-of-phase with the fundamental voltage component of the AC output voltage by no more than plus/minus 30 degrees; and (b) whenever the gas discharge lamp is not so connected, the load current is out-of-phase with the fundamental voltage component of the inverter output voltage by no less than plus/minus 60 degrees.

13. The arrangement of claim 10 wherein the inverter circuit is further characterized in that, when the gas discharge lamp is connected with the load circuit output terminals and is drawing a lamp current therefrom, the fundamental frequency is distinctly lower than when the gas discharge lamp is not so connected.

14. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC supply terminals;

an inverter circuit connected with the DC supply terminals and providing an AC voltage at a pair of inverter terminals; the AC voltage consisting of substantially rectangular voltage pulses of alternating polarity; the voltage pulses occurring at a pulse frequency; each voltage pulse having a pulse duration; the inverter circuit being further characterized by including a control sub-assembly connected in circuit therewithin and operative to control the pulse frequency as well as the pulse duration; the control sub-assembly having a first and a second control input; the pulse frequency being controllable by application of a first control signal to the first control input; the pulse duration being controllable by application of a second control signal to the second control input and in such manner that the pulse duration may be controlled independently of the pulse frequency; and

a load circuit connected with the inverter terminals; the load circuit including a disconnectable gas discharge lamp.

15. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC supply terminals;

an inverter circuit connected with the DC supply terminals and providing an AC voltage at a pair of inverter terminals; the AC voltage consisting of substantially rectangular voltage pulses of alternating polarity; each voltage pulse being separated from the immediately following voltage pulse by a period of near-zero-magnitude voltage; the voltage pulses occurring at a pulse frequency; each voltage pulse having a pulse duration; the inverter circuit being further characterized by including a control sub-assembly connected in circuit therewithin and operative to determine the pulse frequency as well as the pulse duration; the control sub-assembly having a first and a second control input; the pulse frequency being controllable by application of a first control signal to the first control input; the pulse duration being controllable by application of a second control signal to the second control input; and

a load circuit connected with the inverter terminals; the load circuit including a disconnectable gas discharge lamp.

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16. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC supply terminals;

an inverter circuit connected with the DC supply terminals and providing an AC voltage at a pair of inverter terminals; the AC voltage having a fundamental frequency and consisting of half-cycles of alternating polarity; each half-cycle consisting of a substantially rectangular voltage pulse of relatively high magnitude followed by a period of relatively low-magnitude voltage; the period of relatively low-magnitude voltage having a first duration; the substantially rectangular voltage pulse having a second duration; the inverter circuit being further characterized by including a control sub-assembly operative to control the fundamental frequency as well as the second duration; the control sub-assembly having a first and a second control input; the fundamental frequency being controllable by application of a first control signal to the first control input; the second duration being controllable by application of a second control signal to the second control input; and

a load circuit connected with the inverter terminals; the load circuit including a disconnectable gas discharge lamp.

17. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC supply terminals;

an inverter circuit connected with the DC supply terminals and providing an AC voltage at a pair of inverter terminals; the AC voltage having a fundamental frequency and consisting of half-cycles of alternating polarity; each half-cycle consisting of two distinct periods (i) a first period represented by a voltage pulse of substantially rectangular shape and a first magnitude, and (ii) a second period represented by a voltage of low or near-zero magnitude; the inverter circuit being further characterized by including a control sub-assembly operative to control the fundamental frequency as well as the duration of the second period; the control sub-assembly having a first and a second control input; the fundamental frequency being controllable by application of a first control signal to the first control input; the duration of the second period being controllable by application of a second control signal to the second control input; and

a load circuit connected across the inverter terminals; the load circuit including a disconnectable gas discharge lamp.

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18. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC terminals;

a tank-inductor and a tank-capacitor series-connected across a pair of load terminals; the tank-inductor and the tank-capacitor having a natural series-resonance frequency; a gas discharge lamp being disconnectably connected in parallel with the tank-capacitor; a ballast output voltage existing across the tank-capacitor as long as a certain AC voltage is provided across the load terminals; and

an inverter circuit connected between the DC terminals and the load terminals; the inverter circuit being operative to provide the certain AC voltage to the load terminals; the certain AC voltage having: (i) a peak-to-peak magnitude that remains substantially constant irrespective of the magnitude of any current flowing from the inverter circuit to the load terminals, and (ii) a fundamental frequency about equal to said natural series-resonance frequency; the inverter circuit being further characterized by being operative, whenever the gas discharge lamp is non-connected with the tank-capacitor, to cause the magnitude of the ballast output voltage to be limited to a certain substantially constant level, remaining at this substantially constant level for as long as the gas discharge lamp remains non-connected; said certain level being attained without using a clamping-type voltage-limiting means connected in parallel with the tank-capacitor.

19. The arrangement of claim 18 wherein the inverter circuit is additionally characterized in that the fundamental frequency is not higher than the natural series-resonance frequency by more than twenty percent.

20. The arrangement of claim 18 wherein the certain AC voltage is characterized by consisting of alternating rectangularly-shaped voltage pulses separated by periods of zero-magnitude voltage.

21. The arrangement of claim 20 wherein the inverter circuit has a first control input terminal operative, in response to receiving a first control voltage, to control the duration of the alternating voltage pulses.

22. The arrangement of claim 20 wherein the inverter circuit has a second control input operative, in response to receiving a second control voltage, to control the repetition rate of the alternating voltage pulses.

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23. The arrangement of claim 18 wherein the inverter circuit is additionally characterized by having a built-in control sub-assembly operative, by way of its own internal clock means, to determine the frequency of said certain AC voltage.

24. The arrangement of claim 18 wherein the inverter circuit is additionally characterized by including a full-bridge inverter connected in circuit between a pair of DC power input terminals and a pair of AC power output terminals; the DC power input terminals being connected with the DC terminals; the AC power output terminals being connected with the load terminals.

25. The arrangement of claim 18 wherein the inverter circuit is further characterized in that the frequency of said certain AC voltage remains constant to within plus-minus ten percent irrespective of the gas discharge lamp being connected or non-connected with the tank-capacitor.

26. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC terminals;

a tank-capacitor and a tank-inductor series-connected across a pair of load terminals; the tank-capacitor and the tank-inductor having a natural series-resonance frequency; a gas discharge lamp being disconnectably connected in parallel with the tank-capacitor; the gas discharge lamp requiring for proper lamp starting to be provided with a voltage of magnitude at least equal to a certain minimum magnitude; a ballast output voltage existing across the tank-capacitor whenever a certain AC voltage is being provided at the load terminals; and

an inverter circuit connected between the DC terminals and the load terminals; the inverter circuit being operative to provide said certain AC voltage at the load terminals; the certain AC voltage having: (i) a peak-to-peak magnitude that remains substantially constant irrespective of the magnitude of any current being supplied by the inverter circuit to the load terminals, and (ii) a fundamental frequency about equal to said natural series-resonance frequency; the inverter circuit being further characterized by, whenever the gas discharge lamp is non-connected with the tank-capacitor, causing the magnitude of the ballast output voltage to remain substantially constant at a certain level; which certain level is at least equal to said certain minimum magnitude; the certain level being attained without using a clamping-type voltage-limiting means connected in parallel with the tank-capacitor.

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27. The arrangement of claim 26 wherein the inverter circuit is additionally characterized by including a full-bridge inverter connected in circuit between the DC terminals and the load terminals.

28. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC terminals;

a tank-capacitor and a tank-inductor series-connected across a pair of load terminals; the tank-capacitor and the tank-inductor having a natural series-resonance frequency; a gas discharge lamp being disconnectably connected in parallel with the tank-capacitor; the gas discharge lamp requiring for proper lamp starting to be provided with a voltage of magnitude at least equal to a certain minimum magnitude; a ballast output voltage existing across the tank-capacitor whenever a certain AC voltage is being provided at the load terminals; and

an inverter circuit connected between the DC terminals and the load terminals; the inverter circuit being operative to provide said certain AC voltage at the load terminals; the certain AC voltage having: (i) a peak-to-peak magnitude that remains substantially constant irrespective of the magnitude of any current being supplied by the inverter circuit to the load terminals, and (ii) a fundamental frequency about equal to or higher than said natural series-resonance frequency; the inverter circuit being further characterized by including a frequency control sub-circuit operative: (a) whenever the gas discharge lamp is non-connected with the tank-capacitor, to cause the fundamental frequency to be relatively high, thereby to cause the magnitude of the ballast output voltage to be substantially constant and have a magnitude at least equal to said certain minimum magnitude; and (b) when the gas discharge lamp is connected with the tank-capacitor, to cause the fundamental frequency to be relatively low, thereby to cause the gas discharge lamp to be supplied with an appropriate amount of power.

29. The arrangement of claim 28 wherein the inverter circuit is additionally characterized by including a timing sub-assembly having a control input receptive of a control action; the character of which control action uniquely determines the fundamental frequency of said certain AC voltage irrespective of the resonant characteristics of the circuitry present between the load terminals.

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30. An arrangement comprising:

a DC source providing a DC supply voltage at a pair of DC terminals;

a ballast load circuit connected across a pair of load terminals; the load circuit including a pair of ballast output terminals; a ballast output voltage existing across the ballast output terminals whenever a certain AC voltage is being provided at the load terminals; a gas discharge lamp being connected across the ballast output terminals, thereby to be properly powered whenever said certain AC voltage is being provided; and

an inverter circuit having a pair of DC input terminals connected with the DC terminals and a pair of inverter output terminals connected with the load terminals; the inverter circuit being operative to provide said certain AC voltage to the load terminals; the inverter circuit being further characterized by including a first and a second transistor series-connected across the DC input terminals; the first and the second transistor having, respectively, a first and a second pair of control input terminals; a first and a second drive signal existing, respectively, across the first and the second pair of control input terminals; the first drive signal having a waveshape distinctly different from that of the second drive signal.

31. The arrangement of claim 30 wherein the inverter circuit is yet further characterized by also including a third and a fourth transistor series-connected across the DC input terminals; the third and the fourth transistor having, respectively, a third and a fourth pair of control input terminals; a third and a fourth drive signal existing, respectively, across the third and the fourth pair of control input terminals; the third drive signal having a waveshape distinctly different from that of the fourth drive signal.